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Subject ACCIDENTAL RELEASE RADIOACTIVITY HAZARDS RELATIVE TO LOCATION OF HOMOGENEOUS PILE

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By W. H. Ray

To K. Z. Morgan

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ACCIDENTAL RELEASE RADIOACTIVITY HAZARDS RELATIVE TO

LOCATION OF HOMOGENEOUS PILE

WH. Pa.

To be considered in the choice of locations proximal to ~~utilities~~ other facilities the following radioactivity hazards are estimated upon the hypothesis that the homogeneous reactor will have operated one half year at 1 megawatt.

Accidental release of radioactivity may be expected in the form of all the noble gases and volatile substances. Also it is conceivable that 20% of the solution might vaporize in such a way as to disperse the dissolved activity as an aerosol. Such releases should be confined to the reactor's shield. If this is not achieved, the reactor building is a secondary enclosure, the volume of which will largely determine the initial dispersion of activity, if it too should fail.

This initial dispersion is one of the more important factors in attenuation of activity in its course of propagation. A puff from the building or an explosion of the building would establish that the activity were dispersed in a volume exceeding that of the building. If the building retains the activity, migration would not result, but the volume of the building is a conservative minimum unit to employ for estimating propagation.

Under meteorological conditions of temperature gradient inversion there is evidence to suggest that a cloud will not suffer much more than a ten fold dilution in several miles of travel along a valley. Although dilution should be expected to increase with distance, the rate of increase is so low that whether the proposed reactor is in Bethel Valley one or three miles from X-10 makes little difference. Combining this with the conservativeness of the preceding paragraph leads to the estimate that the dilution to be experienced at X-10, should a release drift past, would possibly be only 10 reactor building volumes. The rate of drift under such conditions may be 4 m.p.h.

When winds which would move a cloud of contamination out of the valley and across ridges are experienced, greater velocities prevail, and the variability of direction often accompanying higher winds would add to the turbulence dispersing the cloud over a wider angle than would result from slow drift.

From the standpoint of hazard down wind the concentration of the cloud may be somewhat compensated for by travel time, if this is great enough to permit evacuation. In general, both factors improve with distance. However, high wind velocities which promote dispersal decidedly cut travel time. For situations where the source is close to a vulnerable point and depends on a ridge for confinement of activity to a valley under inversion conditions, the frequency of wind across the ridge toward the vulnerable point becomes a decisive factor as a consequence of short travel distance.

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Hazards to personnel may be either or both irradiation and inhalation of radioactive materials to be fixed in the body. Noble gases will present only the irradiation hazard. To simplify calculations, a cloud of uniform concentration will be considered large enough so that the energy lost per unit volume at the center will equal that absorbed.

For the purposes here considered we shall hypothecate that irradiation at 50 r/hr, concentrations of β activity of 5×10^{-4} $\mu c/cc$, and α concentrations of 5×10^{-6} $\mu c/cc$ will not be fatal. While these values are approximately 10^4 times continuous tolerance figures, the accidental exposure can be limited to less than an hour by evacuation, if the source fails to pass on.

If the average energy of radioactive fission products was 1 Mev (which may be too low by a factor of 2), a concentration of 2.8×10^{-2} $\mu c/cc$ would be needed to attain irradiation of 50 r/hr in the center of a large cloud. Thus, it is seen that except for the noble gases, inhalation is the limiting factor.

A practical building may have dimensions $90' \times 90' \times 60'$ and consequently a volume of 1.81×10^{10} cm^3. Considering the center of a cloud (as above) 50 r/hr would prevail with the dissipation of 6.0 ergs hr^{-1} cm^{-3}, or distributed through a volume equal to that of the building a total dissipation of 10^{11} ergs/hr.

T. H. J. Burnett has computed that at the cessation of 1 megawatt power (maintained for one half year) there would be 2.6×10^{14} ergs/hr radioactive dissipation from Xe and Kr fission products. One hour later the rate of dissipation would be diminished to 5.4×10^{13} ergs/hr. For a site one hour down wind with a presumed dispersion to 10 building volumes the irradiation hazard would be 50 times the suggested 50 r/hr value. In addition to the noble gases the volatile halogens would dissipate 8.68×10^{13} ergs/hr after one hour, thus nearly tripling the radiation hazard.

The initial halogen curies would total 3.34×10^5 and after one hour would be 2.15×10^5. Diluted with 10 building volumes of air this reduces to a concentration of 1.2 μc cm^{-3}.

If 20% of the dissolved fission products were also dispersed in 10 building volumes of air, the inhalation hazard would be tripled by the addition of 2.0 μc cm^{-3}. (This is using the Way - Wigner equation to determine the Mev/sec. 1 hour after power shut down, and assuming 1 Mev per disintegration.)

These quantities of radioactivity, which conceivably may become airborne in an accidental release, exceed by several orders of magnitude values which could be guaranteed to attain dilution to safe concentrations within a radius of several miles. Therefore, other factors than distance alone must be the basis for safety in the selection of sites from the proposed list.

Unless infallible measures to confine releases to the reactor building can be effected, evacuation procedures and rehearsals must be instituted at the plants subject to down wind drift from the homogeneous reactor site.

[redacted]

Similar responsibility for areas off the AEC reservation need be recognized. Time and means to effect evacuation are the alternates to positive confinement.

Of the sites being considered:

C, D, E, H, and G should be rejected because they are in a valley also containing an existing plant. E and H are remote enough to allow evacuation under inversion conditions, but there is also a high frequency of vigorous winds blowing across these points to X-10.

I differs by its elevation, but its exposure and proximity to X-10 favor direct drift under inversion conditions. Therefore it should be rejected. (Inversions prevail during the majority of nights in this area.)

F is somewhat less exposed but still rather high, and being close to the divide gives this location an increased chance of polluting two valleys.

A is better surrounded by hills than F. Its proximity to X-10 requires evacuation in $<$ 15 minutes, but this seems feasible.

B, while closer than A, is shielded from X-10 by Haw Ridge. Winds from the southeast are infrequent, but some months air has been observed coming up through White Oak Creek gap 15% to 20% of the time. This usually is from 3:00 to 5:00 PM and has not been observed under inversion conditions when drift down White Oak Valley would be anticipated.

J also boasts isolation from plant occupied valleys. Its remoteness makes evacuation seem more feasible than the other locations. Placing a reactor at J would make it desirable to incorporate the Gallaher Bend point of land in the reservation. Even so, direct exposure to the Clinch River means that hazardous drifts under inversion conditions could pass over private property. Also, contaminated waste from plant operation and maintenance would go directly to the river. Under vigorous wind conditions the frequency of vulnerability for Y-12 or X-10 (when both are considered) is rather high.

For the above reasons, the writer favors sites B, A, and J in that order and rejects the other selections.

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WHR:mof

1 map attached

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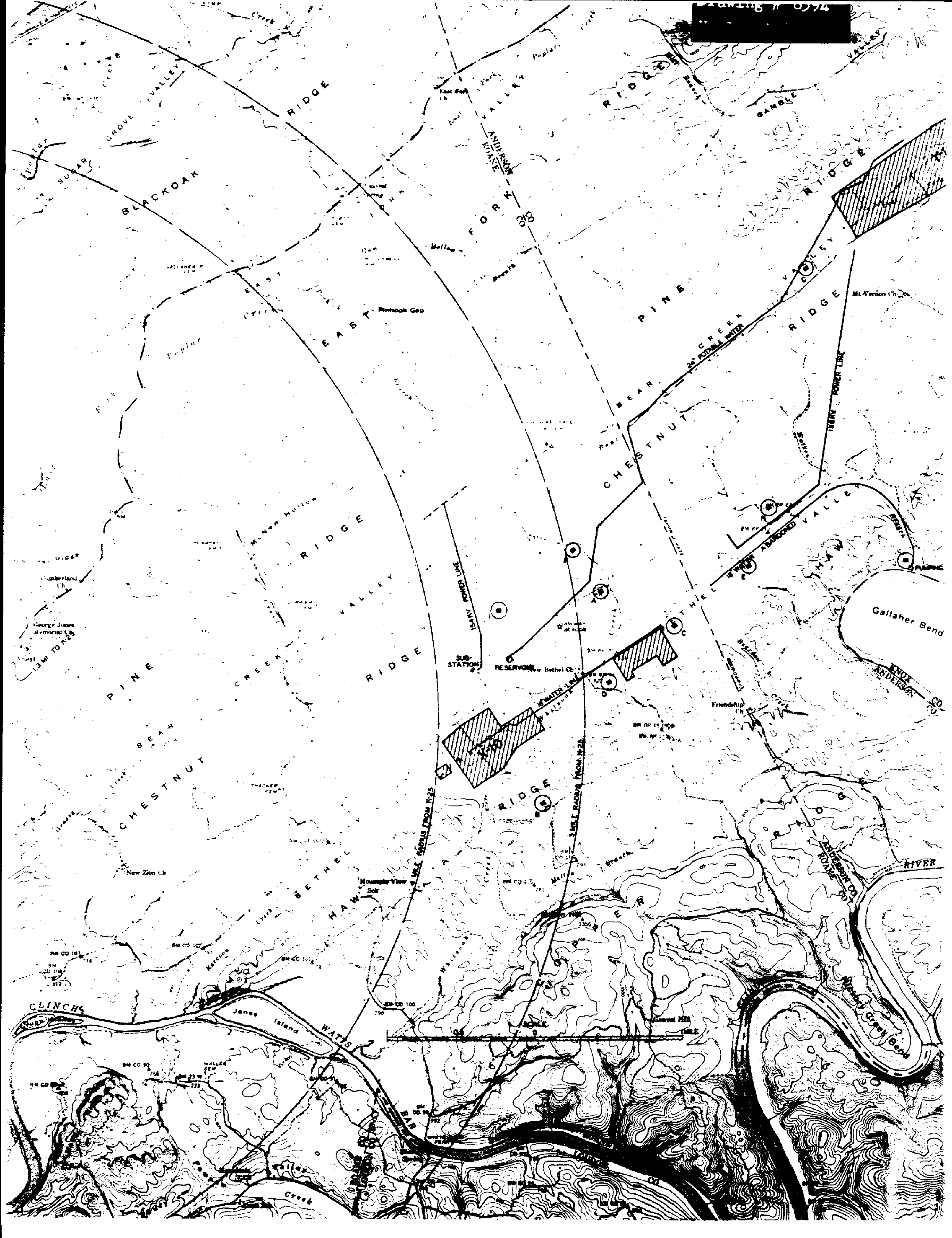

BLACKOAK RIDGE
SUGAR GROVE VALLEY
EAST FORK VALLEY
EAST FORK RIDGE
ANDERSON
ROANE
CO
Pinhook Gap
PINE RIDGE
GAMBLE VALLEY
BEAR CREEK VALLEY
24" POTABLE WATER
154KV POWER LINE
Mt Vernon Ch
CHESTNUT RIDGE
McNew Hollow
PINE RIDGE
BEAR CREEK VALLEY
CHESTNUT RIDGE
BETHEL VALLEY
HAW RIDGE
SUB-STATION
RESERVOIR
New Bethel Ch
16" WATER LINE
ABANDONED
PUMPING
Gallaher Bend
KNOX
ANDERSON
CO
Friendship Ch
K-10
4 MILE RADIUS FROM K-25
3 MILE RADIUS FROM K-25
Cumberland Ch
George Jones Memorial Ch
1.3 MI TO K-25
New Zion Ch
Mountain View Sch
COPPER RIDGE
ANDERSON CO
ROANE CO
RIVER
CLINCH
Jones Island
WATTS BAR
LOUDON CO
Poplar Creek
SCALE
MILE
Melton Branch
Bearden Creek Bend